Main agronomic results of RAS on-farm experimentation network in Jambi

G. Wibawa[1], E. Penot[2], R. Akiefnawati[3] and S. E. Williams[4]

Keywords: Associated Trees, Jungle Rubber, Cinnamon, Biodiversity

Abstract:

Introduction

Rubber is the predominant tree crop in the area of Rantau Pandan and Senamat Districts of Muara Bungo region in the province of Jambi. Most of this rubber is produced by smallholders in areas through jungle rubber systems. The emergence of this complex rubber agroforest was closely related to the slash and burn and shifting cultivation system which has been traditionally practiced by the farmers.

The productivity of rubber on this type of farming system is very low, around 600kg d.r ha-1 per year or between a half and one third of that of monoculture smallholder rubber development projects or estate plantations. Various researchers (Barlow and Muharninto, 1982; Gouyon and Nancy, 1987; Hadi, 1995) have identified the causes of this low productivity:

- old rubber with damaged tapping panel
- native unselected rubber seedlings where the plant yield variability is very high
- density of rubber ranging from very high (more than 800) to low (less than 150) trees per ha, due to the high risk of pests (pig, monkey, deer, tapir) and combinations of other trees.
- longer immature period before tapping

Besides the economic disadvantages, benefits of this complex agroforest can be considered in terms of conservation of a certain level of biodiversity (de Foresta, 1992) and low establish cost in term of labour and capital (cash demand). For the farmers, whose average annual on farm income per household was Rp. 1.3 millions and average total annual expenditure was around Rp 1.2 millions (Gintings *et al.*, 1996), an extensive farming system is the best strategy to continue to provide land and rubber. Average size of land holding for rubber per household on these areas ranged between 0.5 and 4.0 ha and average size of family is 4.8 persons (Gintings, *et al.*, 1996).

---

1 Indonesian Rubber Research Institute, Sembawa Research Station.
2 ICRAF SE Asia Regional program, P.O. Box 161, Bogor, Indonesia.
3 ICRAF Field Manager Jambi Indonesia.
4 School of Agriculture and Forest Sciences, University of Wales, Bangor, Gwynedd, UK

Amypalupy (1994 and 1997) showed that the growth of two year old rubber (GT1 clone) was significantly retarded when Imperata (alang alang) was strip weeded (2m wide) manually three times per year. However when alang alang was weeded chemically, by spraying glyphosate, with the same frequency, the rubber growth was comparable to that where the land was totally weeded. Application of a double dose of recommended fertilizers on chemically weeded plots did not increase the rubber growth. Wibawa *et al*. (1997) showed the stem diameter of rubber of BPM24 clone in clean weeded plots was twice as great as that where the rubber interrows were invaded by a mixture of weeds (shrubs, Imperata, forest regrowth). The difference of stem diameter was observed as early as one year after planting and become statistically significant at two years after planting. Manual strip weeding at least four times a year, in the rubber plots covered with a mixture of perennial shrubby weeds may be applied during the first two years; afterwards a higher weeding frequencies may be needed (Wibawa and al, 1997)

Many questions appear to be very important: how can the productivity of these type of practices be increased? Can the productivity be increased by changing the unselected seedling planting materials with good clonal planting materials, if the same extensive maintenance is applied? Which clones are potentially more adaptive to the extensive maintenance (low level of weeding)? What are the effects of weeds or forest regrowth on rubber growth in RAS 1? Can fertilization compensate for the negative effect of weeds? Which type of trees can be associated to rubber in RAS2?

For RAS 1, the general objectives of the on-farm experiments are:

- to investigate the growth of an improved rubber clone (GT1 or PB260) in conditions close to the jungle rubber (secondary forest regrowth is allowed to grow in inter-row), under various intensities of weeding, with emphasis on the critical first two years of establishment, and to compare the performance of that clone under standard TCSDP (Tree Crop Smallholder Development Project) conditions.
- to compare the growth of four rubber clones (RRIC 100, RRIM 600, BPM1 and PB260) with that of unselected seedlings, under jungle rubber conditions (two intensities of weeding).

For RAS 2, the objectives are:

- to identify the best combination of fruit and timber trees associated with rubber,
- to validate the positive effect of rice or palawija intercropping during immature period of rubber.

Several hypothesis are taken into account:

- Increasing intensity of weeding within the rubber row will result in greater growth of rubber due to a decrease in intensity of competition (above and below ground) from regenerating secondary forest species and response will be different between different clones and unselected seedlings.
- Rubber growth response under such conditions depends on the rubber clone, especially with respect to disease problems. High density of vegetation in

jungle rubber-like conditions, may change the micro climate (air temperature, humidity, soil moisture). High air humidity may increase the risk of disease (especially fungal disease) on rubber. Each clone has a different susceptibility on diseases and adaptability for specific conditions.

Materials and methods

The on-farm trials have been carried out in three villages of Muara Bungo region in Jambi province since December 1995. RAS methodology has been presented in Penot, 1995.

In the system called RAS 1.1, rubber was planted with 6m x 3m spacing in two phases: December 1995 to February 1996 with one whorl GT1 clone in polybag, and October to November 1996 with one whorl PB260 clone in polybag. The first phase of planting was located at two villages: Rantau Pandan in (two farmers' fields) and Muara Buat (three farmers' fields). The second phase of planting was located in Sepunggur village at six farmers' site. In the system called RAS 1.2, in different rubber clones were planted in December 1996 at location in the same villages in five farmers' fields.

RAS 1.1 system

In each farmer's field, a series of treatments were applied and randomized following a standard block design. Each farmer is considered as one replication. The treatments consisted of three levels of strip weeding, compared to one control standard plot (TCSDP):

- Plot A (control): standard smallholder development project (TCSDP) management using leguminous cover crops (LCC) as an intercrop. Manual weeding is carried out nine times a year at 1m of each side of rubber tree rows.
- Plots B, C and D: low, medium and high intensities of strip weeding (2m wide) are applied 3, 6 and 9 times a year respectively.

RAS 1.2 system

The treatment applied consisted of two factors: frequency of strip weeding and rubber planting materials. The first factor has two levels which are 3 and 6 times strip weeding per year and the second factor has five levels: seedling as control, RRIC 100, RRIM 600, BPM 1 and PB 260 clones. As in the RAS 1.1 system, all treatments were applied at each farmers' field except for two farmers where a half of the total treatments, but both with control seedling plot, were implemented: Harahap's plot has two clones (RRIM 600 and BPM 1) and Yusuf's plot has the other two clones (RRIC 100 and PB 260). The size of each plot is around 1000m^2 or a total of 4000m^2 and 10000m^2 in RAS 1.1 and RAS 1.2 respectively.

In all trials, rubber was fertilized with 115g SP36/ tree equivalent to (200g of Rock phosphate) at planting time and 50g of Urea /tree every three months, starting three months after planting.

Characteristics of farmers' land.

The farmers' lands in the study area are characterized by two contrasting topographies: from steep/very steep and flat areas. Most of the first type were located around Rantau Pandan and Muara Buat and the flat lands are located in Sepunggur (except M.Lutan). The original of vegetation was secondary forest, old jungle rubber and fallow of perennial shrubs of different ages (Table 1).

***Table 1a.* Characteristics of farmers' land in two RAS 1 systems**

System/Farmer	Date of planting	Topography	Original of land
RAS 1.1			
Muara Buat			
Bustami			
Saryono 1	Jan. 1996	Very steep	Fallow, shrub, 3 years
Saryono 2	Jan. 1996	Very steep	Secondary forest
	Jan. 1996	Very steep	Secondary forest
Rantau Pandan			
Ismail			
Azahri	Dec. 1995	Very steep	Old jungle rubber
	Feb. 1996	Steep	Fallow, shrub, 5 years
Sepunggur			
A.Jupri			
A.Roni	Oct. 1996	Flat	Fallow, shrub, 5 years
Azwar	Oct. 1996	Flat	Old rubber
Eman	Nov.1996	Flat	Fallow, shrub, 3 years
Sahroni	Oct. 1996	Flat	Old rubber
Zulkifli	Oct. 1996	Flat	Old rubber
	Oct .1996	Flat	Old rubber
RAS 1.2			
Muara Buat			
H. Dur			
Harahap	Nov.1996	Steep	Secondary forest
Yusuf	Oct.1996	Very steep	Secondary forest
	Oct.1996	Very steep	Secondary forest
Rantau Pandan			
M.Lutan			
Sepunggur	Oct.1996	Flat	Secondary forest
A.Roni			
Taridi	Oct.1996	Flat	Secondary forest
	Oct.1996	Flat	Old rubber

Note: Very steep: >75% slope; Steep: 50-75%; Flat: undulating up to 15%

RAS 2 system

Two types of RAS 2 trials have been implemented after preliminary discussions with farmers groups in 3 selected villages: RAS 2.2 (with food intercrops such as rice and palawijas[1]) and RAS 2.5 where rubber is combined with cinnamon.

---

[1] Palawijas are secondary crops such as groundnut, pulses, vegetables, cassava, other roots and tubers basically foodcrops other than rice.

RAS 2.2 experimentation

Some farmers wishes to grow rice or palawijas continuously for the first 3 years after planting during immature period. Different strategies have been observed with the 7 fields (with 7 farmers). The original methodology has not been adopted by farmers and we take the decision to transform the RAS 2.2 replications into an observation trials where we observe or compare different cropping patterns according to farmers strategies. Plots have been reallocated with the following systems with only 2 replications per system. No ANOVA analysis is therefore possible but the qualitative analysis is fruitful and shows very interesting results. We must admit that RAS 2.2 is very successful for some farmers (here again the importance of a relevant operational typology to adapt the type of RAS to the recommendations domains) with a high level of adaptation according mainly to labour resources. Originally, each field is divided with the following plots:

- with and without associated trees,
- rice: with and without fertilization.

Rice has almost failed in all plots in the first year. Palawijas have been very successful except soybean (obviously planted too late) in 1 field (Yani's field).

The new treatments observed are the following:

<u>Experimental design</u>

Treatment: effect on various type of intercropping (with 7 levels) on rubber growth:

1. Control/1**:** alang², clonal rubber = GT 1, 2 rep (Adnan1 , plots A & B)

2. Control/2**:** alang², clonal rubber = PB 260, 2 rep (Adnan1, plots A & B)

Observations: very few weeding: 4 plots completely invaded by alang²

3. Rubber/associated trees + rice/fertilization dose 0, 2 rep (Alias A/Saer A)

4. Rubber/associated trees + rice/dose BPS or CRIFC: 2 rep (Alias B & C)

5. Rubber/associated trees + palawijas, 2 rep (Saer B & C)

This 3 treatments (6 plots) are well weeded (high level of weeding). Rice has failed. Palawijas are successfull. Observations: High number of associated trees in Alias's plots and very high level in Saer's plots.

6. Rubber + Palawija, 2 rep (Sabri A & B)

Observations: Average level of weeding.

7. Rubber /associated trees + local rubber, 2 rep (Sabran, A & B)

(no alang², no palawija): observations: low to average level of weeding + around 300 local rubber seedlings have been planted within the plot, poorly managed. Many associate trees have died but have been replaced by regenerating trees such as jengkol, rambutan, durian.

8. Rubber /associated trees+ palawija (year 1), 2 rep (Joni A, B)

Observations: High level of weeding. At the end of the second year: no more intercrops (many of them have failed or had a low yield).

9. Rubber / no associated trees + palawija (year 1), 2 rep (Joni C & D)

High level of weeding. At the end of the second year: no more intercrops (many of them have failed or had a low yield).

***Table 1b.* Plot characteristics in RAS 2 experiments**

Plot	Rep	As-soc. trees	Intercrops	Farmers' plot	Field's plot	Treatment	Clone
1&2	1&2	no	alang²/control	Adnan1	all	1	GT1
3&4	1&2	no	alang²/control	Adnan1	all	2	PB 260
5	1	no	Palawi-ja1/rice/dose 0	Saer	A	3	GT1
6	2	no	rice/dose 0	Alias	A	3	GT 1
7	1	yes	rice/dose BPS	Alias	B	4	GT1
8	2	yes	rice/dose CIFC	Alias	C	4	GT 1
9	1	yes	palawija 1	Saer	B	5	GT 1
10	2	yes	palawija 1	Saer	C	5	GT 1
11	1	no	palawija 1	Sabri	A	6	GT 1
12	2	yes	Palawija 1	Sabri	B	6	GT 1
13	1	no	no palawija	Sabran	A	7	GT 1
14	2	yes	no palawija	Sabran	B	7	GT 1
15	1	no	palawija 2	Joni	A	8	GT 1
16	2	no	palawija 2	Joni	A	8	GT 1
17	1	yes	palawija 2	Joni	A	9	GT 1
18	2	yes	palawija 2	Joni	A	9	GT 1

Data collection

Soil analysis was carried out, at two soil depths (0-5 and 5-20cm), on pH, Org. C, N, P, K, Ca, Mg, Na, CEC and Al. Aluminum saturation was then calculated. Rainfall was measured manually at three locations, representing the studied areas.

Rubber growth is measured three monthly on stem diameter at 10cm above union at the first year and at 100cm above union thereafter, height and number of whorls. The weeds were characterized qualitatively by average height and coverage.

Rainfall and Soil analysis

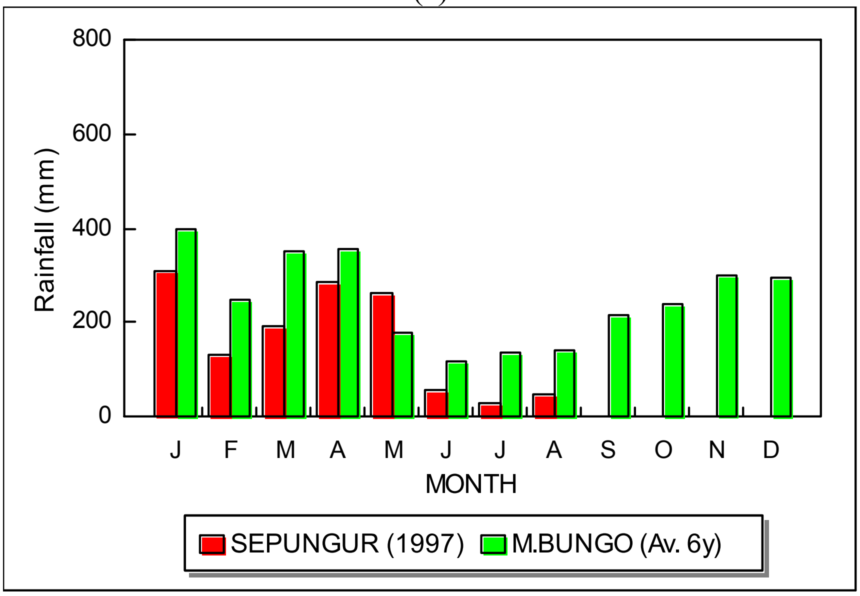
The average annual rainfall around the area of Muara Buat and Rantau Pandan was 2898 mm (six years data from Rantau Pandan station). The rainfall in Rantau Pandan area was lower than that in Muara Buat. From January to June 1997, rainfall in Rantau Pandan was more or less comparable to that of the average of six years at the same period, but in Muara Buat, rainfall over the period January-August 1997 was nearly double of that in Rantau Pandan. In 1997, the period of

March to May was the wettest and June to August was the driest (Figure 1a and 1b).

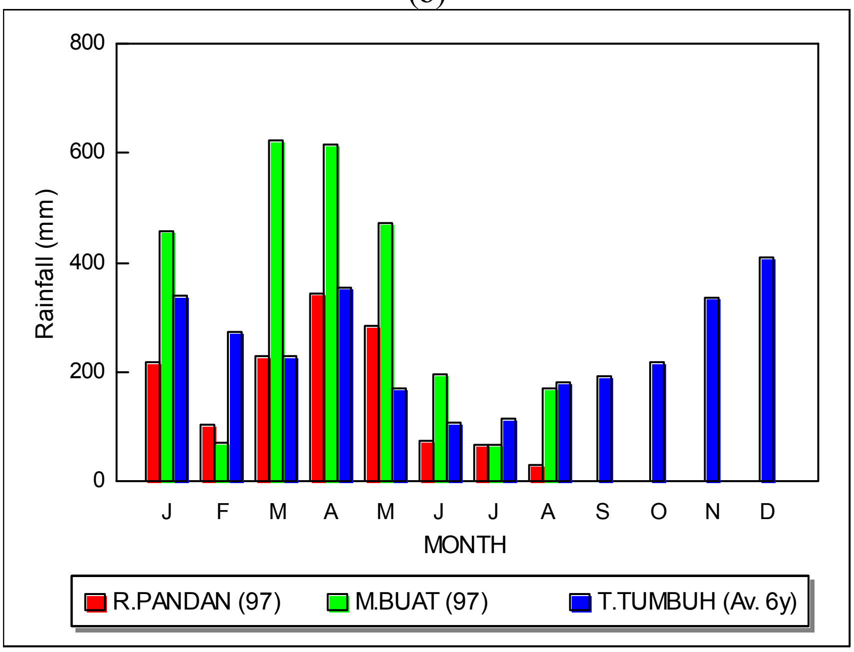
Soils in most farmers' lands are very poor on nutrients, low pH, CEC and high Aluminum saturation (data not shown).

Figure 1. Average rainfall in around and Sepunggur *(a)*, Rantau Pandan and Muara Buat (b) compared to the 6 years data from the closest representative station.

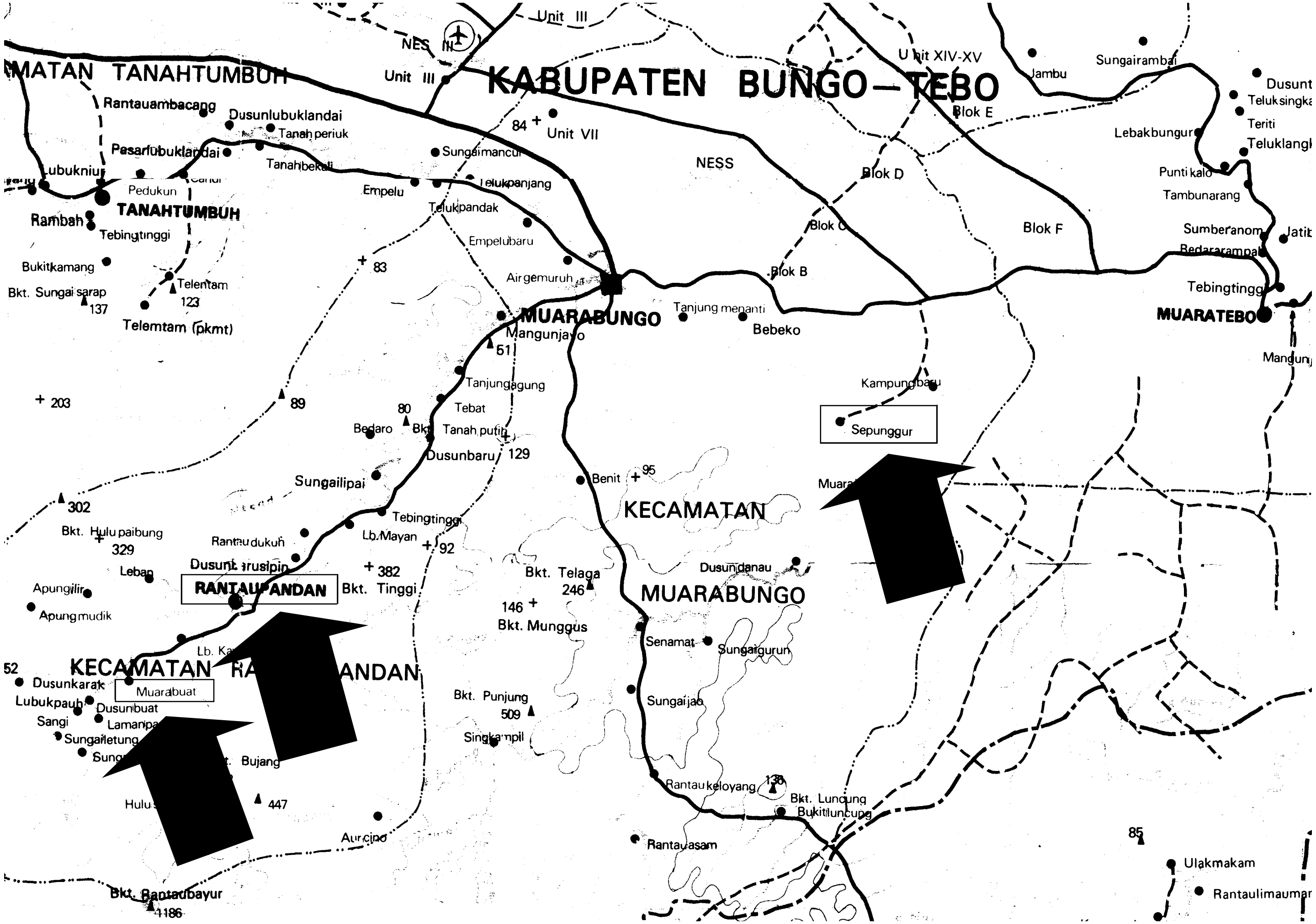
(a)



(b)



Location of the RAS on-farm experimentations, in Muara Bungo, Jambi



Results and discussion

RAS 1.1 system

The effects of frequencies of weeding: 3, 6, 9 times per year (including the control plot in monoculture) are not yet statistically significant (no differences), in all farmers' plots, showing clearly that 3 weeding per year are sufficient to enable rubber to grow properly in an agroforestry environment. Rubber growth on the first phase trials were highly variable among farmers. This variation was mainly due to the factors outside of the weeding treatments (Figure 2). Rubber clones can grow normally on the steep slope like in Ismail's (ISM) field. Rubber growth in this field was not significantly different to that on Azahri (AZR) field where the topography of the latter is less steep than the first (Figure 2).

The stem increment variations within and between farmers' field were higher during the period of May to August (dry season) than during February to May (rainy season) (Figures 2b and 2c). On farmers' lands like those of Bustami (BUS), Saryono1 (SAR1) and Saryono2 (SAR2), the slow rubber growth was due principally to the pest damage (wild pig, red monkey), rather than weeds. The surrounding vegetation seems to be related closely to that damage. In these fields, plots which are located at the border of secondary forest or jungle rubber were damaged more seriously highly than those plots located in the centre of the field.

Muara Buat and Rantau Pandan are representative of pioneer or buffer-zone where agroforestry systems are still very extensive with a relatively low presence in the fields. The proximity of secondary, even sometimes, primary forest is a reservoir of potential pests for improved rubber.

Figure 2a. Effect of frequencies of weeding on stem diameter, at different farmers' fields at 21 months (1st phase).

(a)

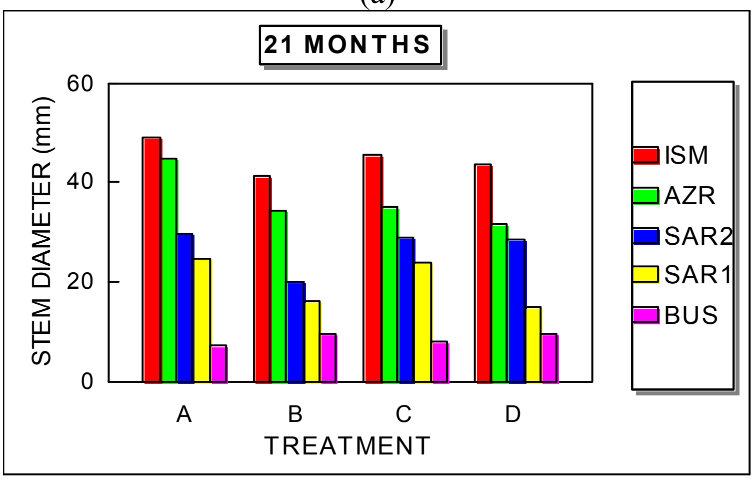
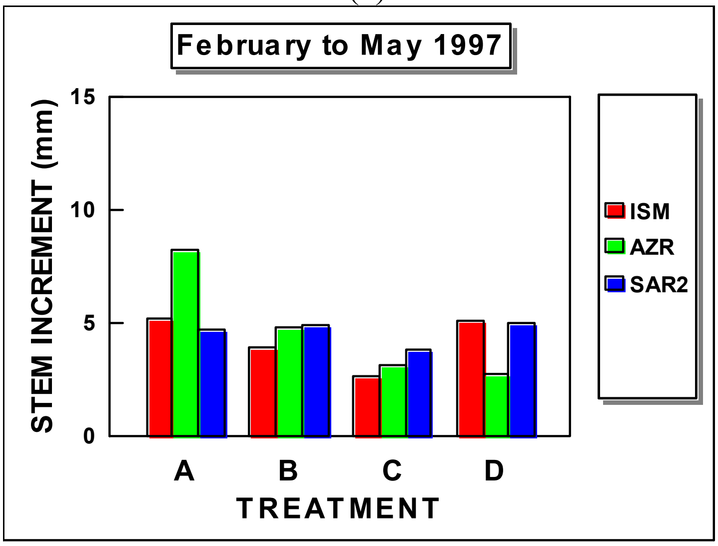
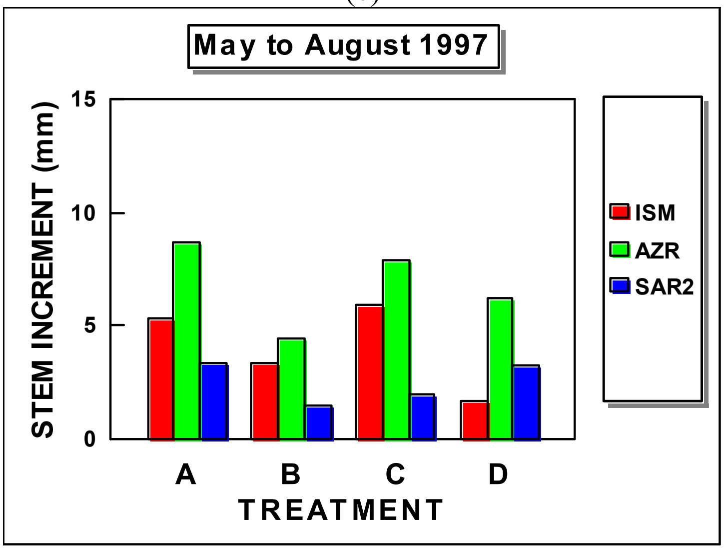


Figure 2 b and c. Effect of frequencies of weeding on stem diameter increment, at different farmers' fields during the period February to May (b) and May to August 1997 (c).

(b)



(c)



Different systems of pest control (fencing, including fences around individual rubber trees, poison, scaring the pests with rifle) have been tried by the farmers and also by the SRAP team to decrease the damage, but non of these methods was totally effective. Any of the system can protect the attack optimally. The existence of a hunting group at Muara Bungo to help farmers to decrease the pest damage may be a good alternative of pest control. It seems that guarding the field (living in the field, coming frequently) may reduce attack. The time available for that activity is very limited, due to the off-farm works which gives farmer s a real cash income.

In the areas with high risk of pest damage, farmers consider that the risk of pest damage is increased when rubber rows are weeded. However, based on our field observations, this statement is not totally true. Most pest damage occurred during the dry period, where the availability of food in the forest is low. Rubber seeds and other fruits are normally available during the wet season, December to March. For simpai (monkey), the young green leaves are also abundant during the rainy season.

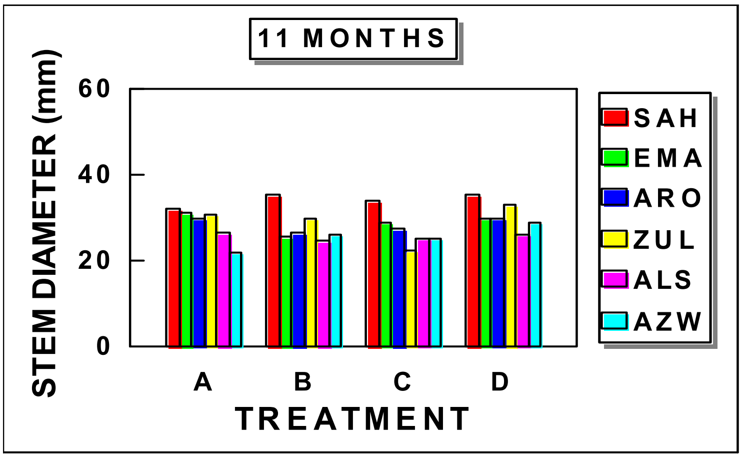
It seems that the main constraints of RAS 1 system in this kind of environment are really pest factors, in particular pigs and monkeys, in particular when population density, or in other words human presence in the fields, is low. This findings may lead to consideration of different important approaches as possible alternatives to reduce this risk: increase rubber density at the beginning of planting, use high stump (core stump) planting materials, fill the gaps within the old rubber field with clonal planting materials.

Results of the second phase of planting on RAS 1.1 in Sepunggur showed that until 11 months of observation, no significant effect of frequencies of weeding on stem diameter of rubber were observed in all farmers' fields. Rubber stem diameter variation among farmers' fields was not significant and lower compared to that among farmers at the first phase (Figure 3a). Rubber stem diameter increment during two different periods were more homogenous during the period February to May than during May to August (Figures 3a and 3b). This result shows that an average of three times weeding a year on the rubber row is sufficient for rubber to compare with the various weeds in the interrow. Pests are not considered as a main constraint in Sepunggur, representative of the peneplain situation.

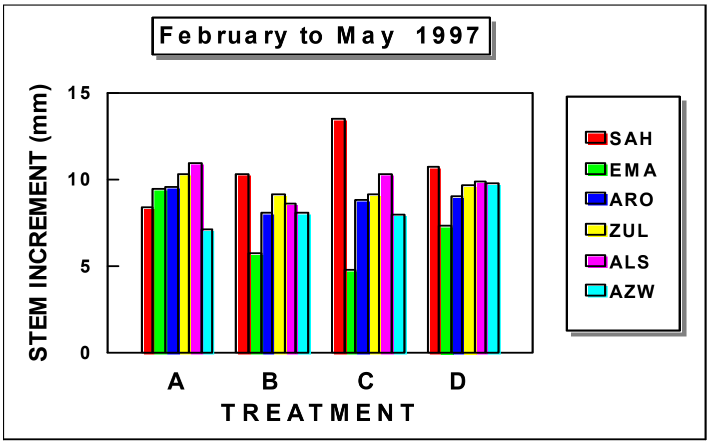
The rubber growth variation among farmers' fields in these areas are lower compared to that observed during the first phase of planting in Rantau Pandan and Muara Buat areas. The preceding vegetation of the land in Sepunggur (Table 1) was mostly old jungle rubber and fallow (shrubs). By slash and burn practices, the dominant weeds grew on those fields were grasses and shrubby broad leaves compared to forest regrowth in the fields derived from secondary forest. The effects of different types of weeds will be important to be analysis during the next coming years.

Figure 3. Effects of frequencies of weeding on rubber stem diameter (a), on stem diameter increment at two periods (b) and (c) at different farmers' fields (2nd phase)

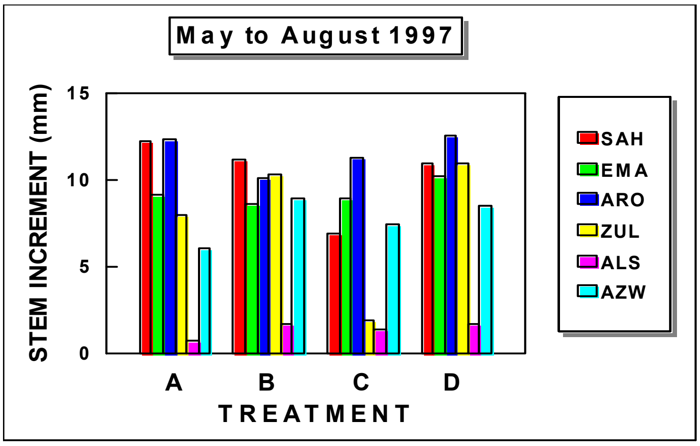
(a)



(b)



(c)



RAS 1.2 system

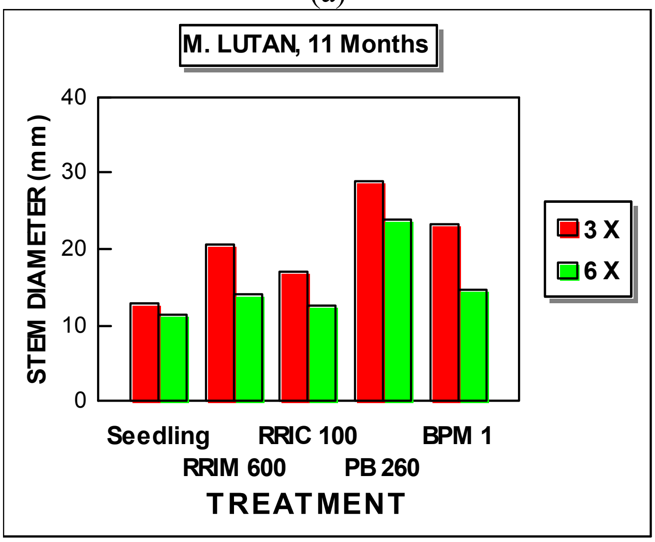
All RAS 1.2 systems planted around October 1996 in Sepunggur , Rantau Pandan and Muara Buat. Like in RAS 1.1, the effects of weeding on the rubber growth were not significant until 11 months. The growth performance of different planting material varied significantly, especially between clones and seedlings. Stem diameter of rubber clone was higher significantly than that of seedlings (not all data are presented) (Figure 4a and 4b). No interaction occurred between clone and frequencies of weeding.

The performance of rubber growth in Sepunggur areas was better and more homogenous than than in Rantau Pandan and Muara Buat areas. However, rubber growth in Jusuf's field (Muara Buat) was comparable to that in Sepunggur (data not shown). The slow growth of seedling, compared to that of clones, was also observed in this field. This farmer is very keen to upkeep his field, by surveying the pests every day during the afternoon. The same problems (pest damage) are found on RAS 1.2 in Muara Buat, in H. Dur's field.

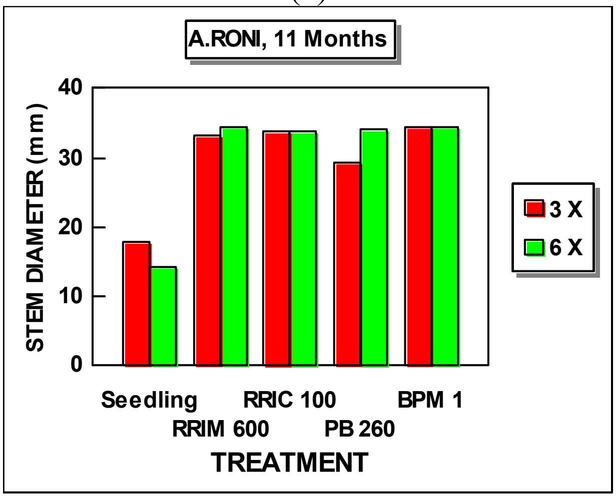
The similar response of rubber growth of different clones on different levels of weeding, especially during the first year, indicated that strip weeding is necessary every four months (3x per year). The tendency of the response of the rubber growth on the treatment was not observed until 21 months. Result from rubber intercropping trials in Sembawa and Batumarta (Wibawa, 1997, Amypalupy, 1994) indicated that if the rubber rows were well upkeep at least every 4 months, the competition between rubber and the intercrops or weeds were observed obviously after two years.

Figure 4. Comparison of stem diameters of 11 month old rubber (clones and seedling) with two levels of weeding at M.Lutan's field in Rantau Pandan (a) and M. Roni's field in Sepunggur (b).

(a)



(b)



RAS 2.2. system

The presence of associated trees is not affecting rubber growth at least during the first years after planting as fruit or timber trees have a slower growth than rubber.

For rice experimentation, 3 doses of fertilization were tried: 0, BPS (medium)and CRIFC (high) (See the trials protocoles for more details, PBS is recommended by BPS/Sembawa and CRIFC is recommended by CRIFC after experimentation in Jambi in 1994/95).

Like all other trials, rubber growth is measured through diameter (Table 2, Figure 5)(10 cm above grafting point), height (Table 3, Figure 6) and total number of whorls (Table 4, Figure 7) every 3 months. The most efficient criteria to measure rubber growth is diameter. Those data showed that plots invaded by alang² (Imperata) are severely affected in terms of rubber growth. The delay in growth can be estimated to minimum 1 year compared to other treatments. The best rubber growth is obtained in treatment 5 and 8 (palawija with high level of weeding), immediately followed by treatment 3, 4, 6 and 7. The effect of growing rice or palawijas (however rice have failed) with the subsequent weeding effect on rubber is quite clear.

Imperata is not a great threat in that area but no weeding and presence of surrounding Imperata before planting lead to the situation in treatment 1 and 2, considered as controls (with imperata). Even a low to average weeding with a high number of associated trees (including local rubber seedlings) does not seem to affect clonal rubber growth as shown in treatment 7. In that last situation, one can observe that local rubber seedlings are higher and have a better growth than clones. These seedlings were supposed to be removed and haven't due to the fact that the farmer has to leave the village. The plot is now managed by his father-in-law (Pak Saer) explaining why the weeding level in inferior to that of treatment 3 to 6.

In other words, farmers have well adapted the RAS 2.2 system according to their labour resources. A high amount of work has ben invested in palawijas, in planting associated trees from small nurseries established by farmers themselves, in selecting the regenerating economically interesting vegetation (mainly fruit trees such as jengkol) in the field and, generally, in a higher level of weeding compared to farmers implementing RAS 1. The small size of cropped land, the proximity of the field close to the house and a strategy definitely oriented in pure agroforestry on both perennial and annual foodcrops with intercrops such as palawijas, rubber, sugar cane, banana, coffee and fruit trees explain the success of RAS 2 in that area.

***Table 2.* Rubber stem diameter in different farmer's fields and at different dates of measurement**

Data Average RAS 2.2

			Time serie 1	2	3	4
Farmer	Code	Plot	Diameter	Diameter	Diameter	Diameter
Adnan	1	A	7.36	12.55	14.64	17.2
		B	7.59	12.66	15.14	16.73
Adnan 1	2	A	7.53	9.19	12.37	13.05
		B	5.47	6.67	10.65	10.33
Saer+Ali	3	A	15.63	22.05	34.46	37.15
		A	9.88	18.69	27.32	28.75
Alias	4	B	10.92	25.29	34.92	35.85
		C		25.14	34.97	36.65
Saer	5	B	15.63	24.53	31.59	38.56
		C		24.20	38.04	39.1
Sapri	6	A	10.69	21.17	29.77	31.73
		B	11.29	23.60	34.65	35.52
Sabran	7	A	11.14	21.11	31.24	34.46
		B	11.01	22.11	33.63	32.71
Yani	8	A	18.58	33.40	42.94	42.56
		B	15.41	27.57	36.69	37.37
Yani	9	C	9.94	20.41	26.62	26.13
		D	10.06	19.43	27.65	26.65

Figure 5. Rubber stem diameter in different farmer's fields and at different dates of measurement

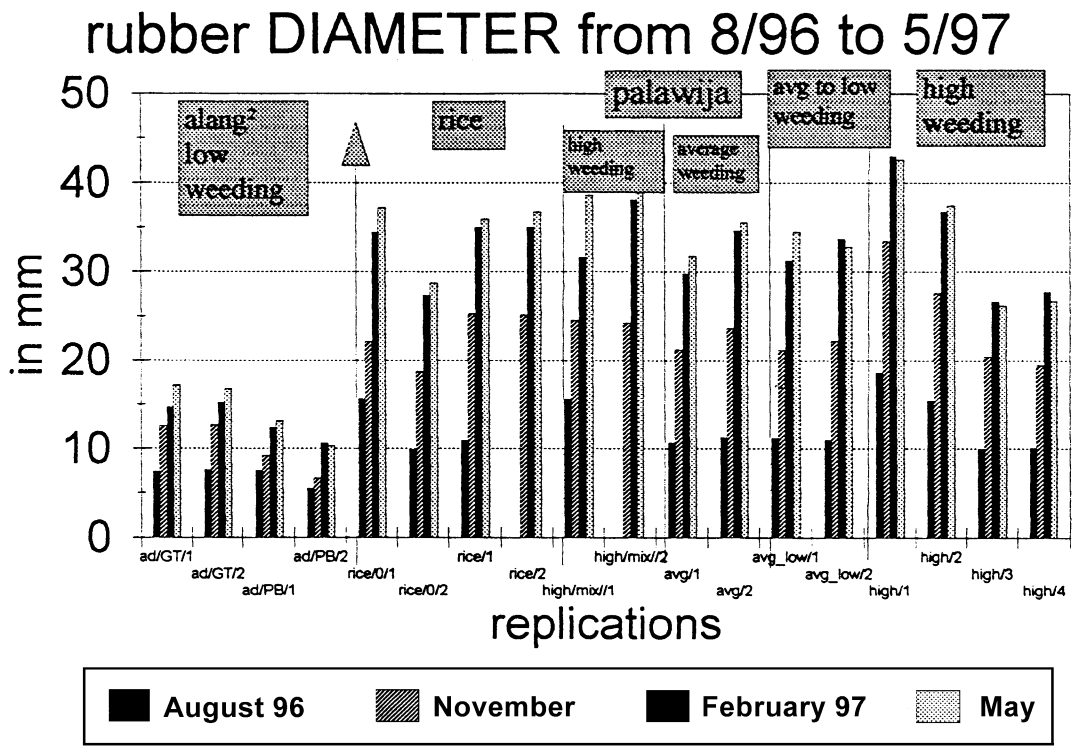
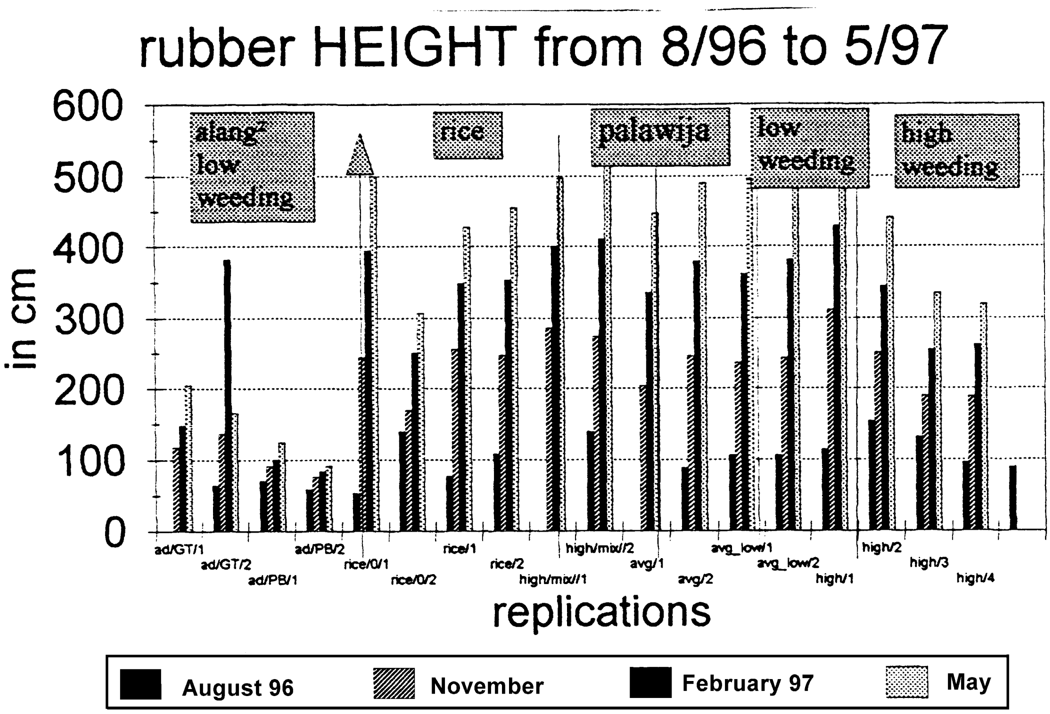


***Table 3*. Rubber height in different farmer's fields and at different dates of measurement**

			Data average RAS 2.2			
			1996		1997	
			August 1	November 2	February 3	May 4
Farmer	Kode	Plot	Height	Height	Height	Height
Adnan GT	1	A	64.70	117.00	148.00	204.43
		B	70.20	136.00	382.00	165.29
Adnan PB	2	A	59.00	91.20	100.00	124.17
		B	53.40	76.40	83.80	90.91
Saer+Alias	3	A	139.86	244.38	394.27	499.47
		A	77.77	169.10	250.10	305.8
Alias	4	B	108.10	255.60	348.00	427.31
		c		247.50	353.70	455.13
Saer	5	B	139.86	285.93	400.17	496.97
		c		273.97	410.57	519.33
Sapri	6	A	88.54	203.89	335.93	446.63
		B	106.27	245.97	379.10	489.59
Sabran	7	A	106.00	236.00	361.07	495.62
		B	114.00	243.00	381.77	490.27
Yani	8	A	153.90	310.50	428.80	500.5
		B	131.80	250.50	343.64	440.5
Yani	9	c	96.13	189.20	254.77	333.93
		D	89.37	188.80	261.30	318.478

Figure 6. Rubber height in different farmer's fields and at different dates of measurement



If such investment continue in the fields, one can expect to have an opening of the rubber trees at 5 years old. Another important feature is that whatever level of maintenance is provide to the fields in the next future (except those invaded by imperata), rubber trees have reached the critical size that ensure their survivability.

Compared to other fields (RAS 1), the rubber growth of most treatment is among the best. Other criteria such as rubber survivability, density of associated trees and palawijas will be later assessed and analyzed.

The low level of pressure of Imperata and Mikania (the 2 most dangerous weeds) and relatively good soils (compared to that of West Kalimantan and West Sumatra for instance), the lack of pests and no incidence of leaf disease (*Colletotrichum)* are certainly explaining partly the success of RAS 2.2.

RAS 2.5 system

Due to the poor management of the farmers and pest damage (pig and red monkey) in these trials located in Muara Buat, the growth of rubber was very low (average height of rubber was no more than 1m in all three farmer's field). The same RAS 2.5 was carried out in Agricultural High School (SMTP) Muara Bungo, planted in October 1996. The effect of cinnamon on rubber growth in this trial was inexistant as most of the cinnamon trees died. They have replaced in 1997 by Petai fruit trees.

Conclusions

Different constraints on rubber growth in different RAS systems, during the first two years of experimentation, were well recorded. The most important constraint was the vertebrate pest damage (monkeys, pigs) which masked the treatment effects, on certain farmers' fields, in particular in hilly areas and remote or buffer zones. The variability of the farmers conditions was caused by a number of bio-physical as well as socio-economic factors.

The advantage of the on-farm trials is that these results are representative of real world conditions. It was possible to identify factors which affect rubber growth in the farmers situation which may actually have a greater influence than the treatments originally planned in the experiments. For example, the extent of the problem of pest damage was not expected, and would not have been detected if experiment were carried out on-station. As a result of the research described above, pest damage has been identified as a major constraint to clonal rubber establishment in pioneer zones, or relatively remote areas, including the piedmont of the Barisan mountains in Sumatra.

In spite of the problems mentioned above, we are still able to conclude that strip weeding of three to four times a year is sufficient to enable good establishment of clonal rubber in the first critical year of weed competition in RAS 1 type systems. It was also observed that the growth of clonal rubber in this condition is better than that of unselected local seedlings. Therefore these results suggest that during the very critical first two years, clonal rubber can survive and grow well in the RAS 1 (rubber+secondary forest) environment.

It's too early to conclude that one clone is definitely best in this environment, however PB260 seem to show consistently good growth.

Concerning RAS 2.2 (Rubber+associated trees+palawija), intercropping of palawija and an average number of associated fruits and timber trees (100 to 150 trees ha-1) does not affect rubber growth as rubber is directly profiting from palawija weeding. It is quite clear that weeding on palawijas and associated trees clearly profit to rubber and enable farmers to optimize their labour input.

RAS 2.5 (rubber+cinnamon) seems to be still an interesting system according to the growing market for cinnamon, but our trials are not representative and we should acknowledge that the site selection has not been successfull.

These preliminary results suggested that RAS 1 and 2 technologies are successfull, in certain conditions and in particularly at the conditions that RAS type is well targeted to farmers class depending on farming strategies.

However, vertebrate pests does not allow RAS development in areas where farmers put priority on very extensive systems (low presence in the fields) or is remote areas, close to existing forest where monkeys and pigs are still in a high number. However RAS 1 maintain a certain level of vegetal biodiversity, in this case this is the surrounding vegetal biodiversity that limits RAS development.

Bibliography

Amypalupy K. 1994. *Pengaruh pengendalian alang alang secara minimal terhadap pertumbuhan tanaman karet rakyat pada periode tanaman belum menghasilkan*. Bull. Perkaretan, 12(1): 10-14

Amypalupy K. 1997. *Pengkajian pengendalian alang alang secara mekanis dan kimiawi pada periode tanaman belum menghasilkan*. Balit Sembawa, KTI-438/a.

Barlow C and Muharminto. 1982. *Smallholder Rubber in South Sumatra*. Toward Economic Improvement. Doc. BPP Bogor dan ANU. 78 pp.

de Foresta H. 1992. *Complex agroforestry system and conservation of biological diversity: for a large use of traditional agroforestry trees as timber in Indonesia, a link between environmental conservation and economic development*. Proceeding of an international conference on the conservation of tropical biodiversity. Malayan Nature Journal.

Gintings et al. 1995. *Characterization Rantau Pandan, Muara Tebo, Jambi: Basic Information for combating deforestation caused by Slash and Burn Agriculture*. Paper presented at Regional workshop on Alternatives to Slash and Burn.

Gouyon A and C Nancy. 1989. *Increasing the productivity of rubber smallholder in Indonesia: a study of agro-economic constraints and proposals*. Paper presented at Rubber Growers Conference. 26pp.

Hadi PU et al. 1995. *Socio-economic characterization of Slash and Burn Agriculture at the community level in three ecological zones of Sumatra, Indonesia*. Paper presented at Regional workshop on Alternatives to Slash and Burn.

Wibawa G and Thomas. 1997. *Study of hevea based intercropping system functioning: A. Effect of different intercrops on rubber growth*. Paper presented on Seminar on study of hevea based intercropping system functioning. Balit Sembawa. 25pp.